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Distribution and Antimicrobial Susceptibility Profile of Extended Spectrum Beta-Lactamase Producing-*Escherichia coli* from Ruminants in Maiduguri, Nigeria: Public Health Implication

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ABSTRACT

Extended spectrum beta-lactamase (ESBL) producing *Escherichia coli* (*E. coli*) is resistant to many antibiotics, including cephalosporins and penicillin. The emergence of ESBL-*E. coli* poses a threat to the entire animal and human community, not just individuals with direct exposure to ruminants but also to the environment. The study evaluated the isolation rate and antimicrobial susceptibility profile of ESBL-producing *E. coli* from 128 ruminants in the University of Maiduguri campus. *E. coli* was isolated from 32 (25%) of the rectal swabs collected from cattle, goats, and sheep. ESBL-producing *E. coli* was more common in young animals 8(30.8%) than in adult animals 12 (11.8%). More than 80% of the isolates were resistant to all of the beta-lactam antibiotics used in the study. The study suggests that the high prevalence of ESBL-producing *E. coli* in ruminants may be associated with the unregulated use of beta-lactam antibiotics in veterinary practice and animal husbandry. We recommend public health awareness about the dangers of antimicrobial resistance. Also, continued monitoring of BL-*E. coli* prevalence in both animals and humans is crucial to track trends and guide interventions. Promoting the judicious use of antibiotics in both human and veterinary medicine is essential to reduce selective pressure for resistance development. Improved hygiene practices at farms, slaughterhouses, and food processing facilities can minimize contamination and human exposure.

Key words: Antimicrobial Resistance; Cephalosporins; *E. Coli*; Multiple resistant; Ruminants; Zoonoses.

INTRODUCTION

Antimicrobial resistance (AMR) is a global problem in the treatment of infectious diseases (Chukwu *et al*., 2021). AMR is a significant public health concern with societal, and economic consequences (Dhingra *et al*., 2020). It is a rising problem for public, and community health in developing countries (WHO, 2020). There are different forms of antimicrobial resistance, such as resistant to beta lactam antibiotics, and extended spectrum cephalosporins.

Extended spectrum beta-lactamase (ESBL) is an enzyme that can be found in some strains of *E. coli* and other Gram-negative bacteria. ESBL-producing *E. coli* (ESBLPE) are resistant to Beta-lactam antibiotics. Beta-lactam antibiotics are bactericidal antibiotics that contain a beta-lactam ring in their chemical structure. They include Penicillins, Cephalosporins, Monobactams, Carbapenems Carbacephems. Beta-lactam antibiotics bind to and inhibit penicillin binding proteins (PBPs). This interrupts bacterial cell-wall formation. The most common bacteria that produce ESBLs are *E. coli* and *Klebsiella pneumoniae*. These bacteria are found in the gut of animals and humans, even when healthy (Rawat and Nair, 2010).

Beta Lactamase is sensitive to β-lactamase inhibitors such as sulbactam, clavulanic acid, and tazobactam (Mukherjee *et al*., 2013). These ESBLs producer are identified among members of the *Enterobacteriaceae* which may harbour several determinants of antibiotic resistance, making treatment of infections caused by these pathogens more difficult and challenging to public health (Rottier *et al*., 2012). The ESBLs producers have complex epidemiology; the most prominent bacteria involved include *Escherichia coli, Klebsiella pneumonia*, and *Salmonella* species.

Food animals such as cattle, sheep and goats colonized with ESBL-producing bacteria can enhance the spread of the bacteria at the community level (Bortolaia *et al.,* 2010; Bennett *et al*., 2013). Studies indicate a significant presence of Beta Lactamase producing *E coli* (BLPE) in Nigerian ruminants, particularly cattle (Ejikeugwu *et al*., 2019; Ebule *et al*., 2020; Onuoha *et al*., 2023). The

prevalence varies depending on factors like location, type of ruminant, and husbandry practices. For example, a recent study found a prevalence of 45.4% for extended-spectrum beta-lactamase (ESBL)-producing *E. coli* among cattle in two major abattoirs in Lagos and Abuja (Aworh *et al*., 2022).

Escherichia coli is an important gastrointestinal pathogen that causes diarrhoea, and this appeared to be reported frequently in calves, lambs, and kids (Dipeolu, 2010, Raji, 2014). Domestic and wild animals are sources of *E. coli*. Ruminants, primarily sheep, goats and cattle have also been identified as major reservoirs and sources for human infection (Rahimi *et al*., 2012).

Most studies that evaluate the isolation rate of ESBL-producing *E. coli* in Nigeria were carried out in abattoir slaughtered animals (Dipeolu, 2010; Raji, 2014; Ejikeugwu *et al*., 2019; Ebule *et al*., 2020; Onuoha *et al.,* 2023). There is a lack of evidence of ESBL- producing *E. coli* among ruminants that are reared in households or residential areas in Nigeria. Household subsistence farming is a major source of income for many families in Nigeria, especially in resource poor settings like the Northeast Nigeria which is bedeviled with humanitarian crises resulting from the Boko Haram insurgency. Although household animal rearing provides economic support for most poor families in Borno State, the practice could be a source of zoonotic and antimicrobial resistant strains for members of the family and the community.

A great number of outbreaks of infections which are caused by ESBL producing organisms have been described in every continent of the globe (Mukherjee *et al*., 2013). And there is evidence that suggests the spread of ESBL infections occurs higher in resource poor countries (Chander *et al*., 2013). Antimicrobial resistance (AMR) is regarded as a major global crisis and an emerging public health threat, involving both human and animal health (Schrijver *et al*., 2018). High rate of antimicrobial resistant has been reported in Nigeria. This could be associated with unregulated antibiotic usage, over-the counter drug sales without prescription, and treatment of patients without laboratory tests or results, which are all too common in underdeveloped nations (Ogefere *et al*., 2009). This phenomenon has been linked to the indiscriminate use/misuse of antibiotics in veterinary medicine, human medicine, and agriculture (Shaikh *et al*., 2015). The transmission of resistant bacteria from animals to humans is a matter of serious concern with the possibility of cross-species transmission (Schrijver *et al.,* 2018). Hence, this study aimed to determine the isolation rate of multiple antimicrobial resistant beta-lactamase producing *Escherichia coli* from in cattle, sheep and goat reared within the University of Maiduguri staff residential areas and farms.

MATERIALS AND METHODS

Study Area

The study area was conducted in the University of Maiduguri (UNIMAID) campus located in Maiduguri, the capital city of Borno state in Northeast Nigeria. The University is located at the geographic coordinate 11.8049°N; 131970°E (Figure 1). The university was created by the Federal Government of Nigeria in the year 1975, with the intention of it becoming one of the country's principal institutions (Atabong *et al.,* 2016). With the encouragement of the Federal Government, the University has recently been increasing its teaching and research efforts particularly in the fields of Agriculture, Medicine, and Conflict resolution. The university is the major higher institution of learning in the north-eastern part of the country. The institution currently has the following Faculties: Veterinary Medicine, Agriculture, Engineering, Sciences, Arts, Education, Law, Social sciences, Management Sciences, Pharmacy, Allied Health Sciences, Environmental Sciences, Basic of Medical Sciences and College Medicine. The University has a population of over 30000 students, staff, and business operators.

The university staff quarters accommodate both senior and junior academic and non-academic members of the university. Some members of the university staff keep animals as a source of alternate income.

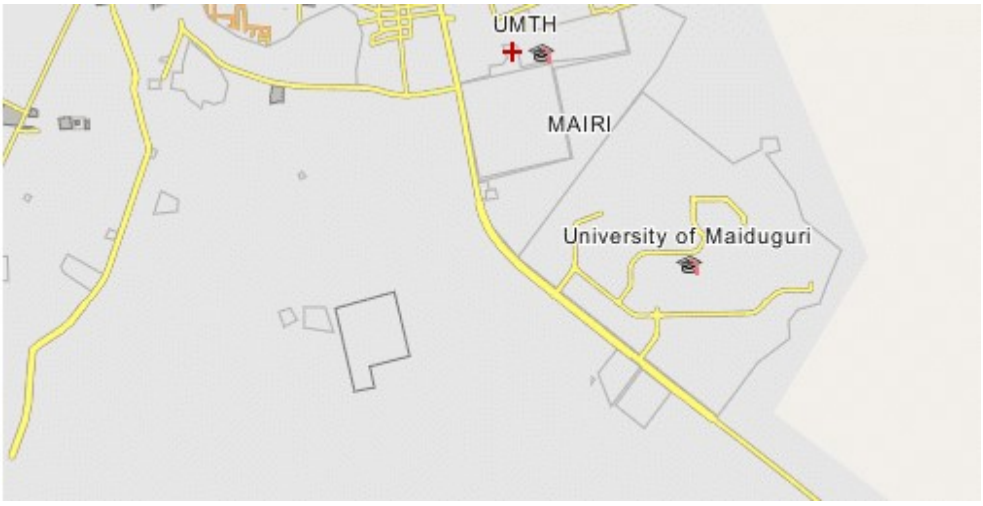

Figure 1: Map of the University of Maiduguri (Rural Electrification Agency, 2021)

Study Design and Sample collection

A cross-sectional approach was made to determine the isolation rate of *Escherichia coli* and multiple antimicrobial profile of extended spectrum Beta-Lactamase producing *E coli* from ruminants (cattle, sheep, and goats) in University of Maiduguri residential areas and school farm. A total of 128 rectal swabs used were aseptically collected, labelled, and transported to the University of Maiduguri Veterinary Microbiology Laboratory located at Academic Area of University of Maiduguri Campus for bacteriological analyses.

Bacterial Culture and Isolation

The samples were inoculated into 5 ml of MacConkey broth, well labelled and incubated at 37°C 37^0C for 24 hours. The broth culture was then inoculated onto MacConkey agar using sterile wire loop. Streaks were made from the pools across the agar and then incubated at 37°C for 24 hours (Cheesbrough, 2005). After 24 hours of incubation, the plates were examined for evidence of bacterial growth. Suspected bacterial colonies were then subcultured for purity onto MacConkey agar (Cheesbrough, 2005) and then preserved on nutrient agar slant at +4 °C for a period not more than 7 days for further use. The final pure cultures were confirmed to be *E. coli* using the standard biochemical tests like indole, methyl red, Voges Proskauer and citrate utilization (IMViC) tests.

Isolation of Extended Spectrum Beta-Lactamase-producing *Escherichia coli*

The isolation of ESBL- producing *E. coli* was carried out by using HiCrome ESBL Agar The test organisms were inoculated onto CHROMagar and then incubated at 37°C for 18–24 hours. Colonies of ESBL producers develop species-specific colors. ESBL producing *E. coli* grows as either purple or pink colonies.

Antimicrobial Sensitivity Test (AST)

Susceptibility tests were performed on all the isolates recovered using Kirby Bauer's disk diffusion method on Muller-Hinton agar medium as described in the guidelines of the Clinical Laboratory Standard Institute (CLSI 2020; Wayne, 2015). The antibiotics used include Imipenem (10/10µg), Ofloxacin (5µg), Nalidixic acid (30µg), Cefotaxime (25 µg), Gentamicin (10 µg), Amoxicillin/Clavulanate (30/10 µg), Nitrofurantoin (300 µg), Amplicox (10µg), cefexime (5 µg), Levofloxacin (5µg), cefuroxime (30 µg) and Ceftriaxone sulbactam (45µg). A standardized suspension of each isolate equivalent to 0.5 McFarland standards was inoculated onto Mueller Hinton agar plates and the antibiotics disc was aseptically placed on the agar plates and incubated at 37°C for 18-24 hours. After incubation, the diameter of the zone of inhibition was measured and recorded according to the incubation as per the CLSI guidelines (CLSI, 2020).

RESULTS

Characteristic of the animals used in this study

The samples used for this study comprise of rectal swab from of cattle 10 (7.8%), goat 76 (59.4%), and 42 (32.8%) sheep. The adults were 102 (79.7%), young 26 (20.3%). Male were 58 (45.3%), female 70 (54.7%). Body condition showed thin 16 (12.5%), medium 68 (53.1%), and fat 44 (34.4%) (Table 1).

Table 1: Demographic Data of the Study Animals in the University of Maiduguri

S/No	Variables	Frequency	Percentage (%)
1	Age group		
	Adult (	102	79.7
	Young	26	20.3
2	Sex		
	Male	58	45.3
	Female	70	54.7
3	Body condition		
	Thin	16	12.5
	Medium	68	53.1
	Fat	44	34.4
4	Species		
	Cattle	10	7.8
	Goat	76	59.4
	Sheep	42	32.8
	Total	**128**	**100.0**

Distribution of Lactose Fermenting *Enterobacteriaceae* Isolated from the Rectum of Ruminants at the University of Maiduguri Campus

Out of 128 samples collected, the isolation rate of lactose fermenting *Enterobacteriaceae* from adults were 84 (82.4%), and young 20 (76.9%). Male had 50 (86.2%) and female had 54 (77.1%) lactose fermenters. Thin animals had the highest isolation rate 14 (87.5%) while animals with fat body condition had the lowest isolation rate 34 (77.3%). Sheep had the highest isolation rate 36 (85.7%) compared with other species (Table 2).

Table 2: Distribution of Lactose Fermenting *Enterobacteriaceae* Isolated from the Rectum of Ruminants at the University of Maiduguri Campus

Variable	Samples (%)	Non-Lac. fermenters (%)	Lac. fermenters (%)	χ^2 (P-value)
Age				
Adult	102 (79.7)	18 (17.6)	84 (82.4)	0.401 (0.527)
Young	26 (20.3)	6 (23.1)	20 (76.9)	
Sex				
Male	58 (45.3)	8 (13.8)	50 (86.2)	1.711 (0.191)
Female	70 (54.7)	16 (22.9)	54 (77.1)	
Body condition				
Thin	16 (12.5)	2 (12.5)	14 (87.5)	21 (0.631)
Medium	68 (53.1)	12 (17.6)	56 (82.4)	
Fat	44 (34.4)	10 (22.7)	34 (77.3)	
Species				
Catte	10 (7.8)	4 (40.0)	6(60.0)	3.519 (0.172)
Goat	76 (59.4)	14 (18.4)	62(81.6)	
Sheep	42 (32.8)	6 (14.3)	36(85.7)	
Total	**128 (100.0)**	**24 (18.8)**	**104 (81.2)**	

χ^2 = Chi-square

Distribution of *E. coli* Isolated from the Rectum of Ruminants in the University of Maiduguri Campus

Out of 128 isolated samples; the isolation rate of *E. coli* by using Eosin methylene blue agar (EMBA) and Biochemical tests (Figure 1, and 2) from adults were 22 (21.6%), and young 10 (38.5%). Male had 20 (34.5%), and female had 12 (17.1%) *E. coli* isolate. Thin animals had the highest isolation rate 10 (62.5%) while animals with fat body condition had the lowest isolation rate 8 (18.2%). Goats had the highest isolation rate 26 (34.2%) *E. coli* isolates compared with other species (Table 3).

Table 3: Distribution of *E. coli* Isolated from the Rectum of Ruminants in the University of Maiduguri Campus

Variables	Samples (%)	Non-*E. coli* (%)	*E. coli* (%)	χ^2 (P-value)
Age				
Adult	102 (79.7)	80 (78.4)	22 (21.6)	3.153 (0.076)
Young	26 (20.3)	16 (61.5)	10 (38.5)	
Sex				
Male	58 (45.3)	38 (65.5)	20 (34.5)	5.086 (0.024)
Female	70 (54.7)	58 (82.9)	12 (17.1)	
Body Condition				
Thin	16 (12.5)	6 (37.5)	10 (62.5)	13.797 (0.001)
Medium	68 (53.1)	54 (79.4)	14 (20.6)	
Fat	44 (34.4)	36 (81.8)	8 (18.2)	
Species				
Cattle	10 (7.8)	8 (80.0)	2 (20.0)	8.937 (0.011)
Goat	76 (59.4)	50 (65.8)	26 (34.2)	
Sheep	42 (32.8)	38 (90.5)	4 (9.5)	
Total	**128 (100)**	**96 (75.0)**	**32 (25.0)**	

χ^2 = Chi-square

Distribution of ESBL Producing *E. coli* Isolated from the Rectum of Cattle, Sheep, and Goat from the University Maiduguri Campus

Out of 128 isolated samples, the isolation rate of ESBL producing *E. coli* from young animals were (8 (30.8%), and adults 12 (11.8%). Goats had the highest isolation rate of ESBL producing *E. coli* 18 (23.7%) compared to other species. Male had 12 (20.7%) isolation rate, while female had 8 (11.4%). Thin animals had the highest isolation rate of ESBL producing *E. coli* 4 (25.0%) compared with animals with fat and medium body condition (Table 4). *Escherichia coli* appeared pinkish or purple on HI chrome ESBL agar (Figure.3).

Antimicrobial Susceptibility Profile of *Enterobacteriaceae* Isolated from the Rectum of Cattle, Sheep, and Goat in University of Maiduguri Campus

The result of antimicrobial susceptibility testing for 90 isolates against 12 different antibiotics showed that Ninety (100%) isolates were resistant to Cefexime, Amoxicillin Clavulanic acid, and Cefotaxime. Eighty-eight (97.8%) isolates were resistant to Ceftriaxone and Imipenem. Eighty-two (91.1%) isolates were resistant to Ampiclox and Cefuroxime. Seventy-six (84.4%) isolates were sensitive to Ofloxacin, sixty-four (71.1%) isolates were sensitive to Gentamycin. and thirty (33.3%) isolates

were intermediate to Levofloxacin (Table 5, and Figure 4).

Table 4: Distribution of ESBL Producing-*E. coli* Isolated from the Rectum of Cattle, Sheep, and Goat from the University Maiduguri Campus

Variables	Sample (%)	Non-ESBL (%)	ESBL producing *E. coli* (%)	χ^2 (P-value)
Age				
Adult	102 (79.7)	90 (88.2)	12 (11.8)	5.676(0.017)
Young	26 (20.3)	18 (69.2)	8 (30.8)	
Sex				
Male	58 (45.3)	46 (79.3)	12 (20.7)	2.064(0.151)
Female	70 (54.7)	62 (88.6)	8 (11.4)	
Body condition				
Thin	16 (12.5)	12 (75.0)	4 (25.0)	2.702(0.259)
Medium	68 (53.1)	56 (82.4)	12 (17.6)	
Fat	44 (34.4)	40 (90.9)	4 (9.1)	
Species				
Cattle	10 (7.8)	10 (100.0)	0 (0.0)	12.393(0.015)
Goat	76 (59.4)	58 (76.3)	18 (23.7)	
Sheep	42 (32.8)	40 (95.2)	2 (4.8)	
Total	**128 (100.0)**	**108 (84.4)**	**20 (15.6)**	

χ^2 = Chi-square

Table 5: Antimicrobial Susceptibility Profile of Enterobacteriaceae Isolated from the Rectum of Cattle, Sheep, and Goat in University of Maiduguri Campus (n = 90)

Antibiotics	Susceptible (%)	Intermediate (%)	Resistant (%)
Nitrofurantoin (NF)	12(13.3)	24(26.7)	54(60.0)
Cefuroxime (CXM)	2(2.2)	6(6.7)	82(91.1)
Ceftriaxone (CRO)	2(2.2)	0(0)	88(97.8)
Ampiclox (ACX)	2(2.2)	6(6.7)	82(91.1)
Cefexime (ZEM)	0(0)	0(0)	90(100.0)
Levofloxacin (LBC)	38(42.2)	30(33.3)	22(24.4)
Amoxicillin clavulanic acid (AUG)	0(0)	0(0)	90(100.0)
Cefotaxime (CTX)	0(0)	0(0)	90(100.0)
Imipenem (IMP)	0(0)	2(2.2)	88(97.8%)
Ofloxacin (OFX)	76(84.4)	4(4.4)	10(11.1)
Gentamycin (GN)	64(71.1)	8(8.9)	18(20.0)
Nalidixic acid (NA)	10(11.1)	16(17.8)	64(71.1)

Antimicrobial Susceptibility Profile of *E. coli* Isolated from the Rectum of Cattle, Sheep, and Goats in University of Maiduguri Campus

The result of antimicrobial sensitivity testing for 30 E. coli isolates against 12 different antibiotics showed that thirty (100%) isolates were resistant to Ceftriaxone, Cefexime, Amoxicillin clavulanic acid, Cefotaxime and Imipenem, followed by twenty-eight (93.3%) isolates were resistant to Ampiclox, twenty-six (86.7%) isolates were resistant to Cefuroxime respectively. eighteen (60%) isolates are intermediate to Nitrofurantoin, twelve (40%) isolates were intermediate to Nalidixic acid. Twenty-four (80%) isolates are sensitive to Ofloxacin, and twenty-two (73.3%) isolates were sensitive to Gentamycin (Table 6).

Table 6: Antimicrobial Susceptibility Profile of *E. coli* Isolated from the Rectum of Cattle, Sheep, and Goats in University of Maiduguri Campus (n = 30)

Antimicrobials	Susceptible (%)	Intermediate (%)	Resistance (%)
Nitrofurantoin (NF)	2(6.7)	18(60.0)	10(33.3)
Cefuroxime (CXM)	0(0.0)	4(13.3)	26(86.7)
Ceftriaxone (CRO)	0(0.0)	0(0.0)	30(100.0)
Ampiclox (ACX)	2(6.7)	0(0.0)	28(93.3)
Cefexime (ZEM)	0(0.0)	0(0.0)	30(100.0)
Levofloxacin (LBC)	16(53.3)	4(13.3)	10(33.3)
Amoxicillin clavulanic acid (AUG)	0(0.0)	0(0.0)	30(100)
Cefotaxime (CTX)	0(0.0)	0(0.0)	30(100)
Imipenem (IMP)	0(0.0)	0(0.0)	30(100)
Ofloxacin (OFX)	24(80.0)	2(6.7)	4(13.3)
Gentamycin (GN)	22(73.3)	0(0.0)	8(26.7)
Nalidixic acid (NA)	4(13.3)	12(40.0)	14(46.7)

Antimicrobial Susceptibility Profile of ESBL Producing *E. coli* Isolated from the Rectum of Cattle, Sheep, and Goats in University of Maiduguri Campus.

The result of antimicrobial sensitivity testing for 14 ESBL producing-E. coli against 12 different antibiotics showed that fourteen (100%) isolates were resistant to Ceftriaxone, Cefexime, Amoxicillin clavulanic acid, Cefotaxime, and Imipenem, twelve (85.7%) isolates were resistant to cefuroxime and Ampiclox, eight (57.1%) isolates were resistant to Nalidixic acid, twelve (85.7%) isolates were intermediate to Nitrofurantoin, ten (71.4%) isolates were sensitive to Ofloxacin and Gentamycin (Table 7).

Table 7: Antimicrobial Susceptibility Profile of ESBL Producing *E. coli* Isolated from the Rectum of ruminants in the University of Maiduguri Campus (n = 14)

Antibiotics	Susceptible (%)	Intermediate (%)	Resistance (%)
Nitrofurantoin (NF)	2 (14.3)	12 (85.7)	0 (0)
Cefuroxime (CXM)	0 (0)	2 (14.3)	12 (85.7)
Ceftriaxone (CRO)	0 (0)	0 (0)	14 (100)
Ampiclox (ACX)	2 (14.3)	0 (0)	12 (85.7)
Cefexime (ZEM)	0 (0)	0 (0)	14 (100)
Levofloxacin (LBC)	8 (57.1)	2 (14.3)	4 (28.6)
Amoxicillin clavulanic acid (AUG)	0 (0)	0 (0)	14 (100)
Cefotaxime (CTX)	0 (0)	0 (0)	14 (100)
Imipenem (IMP)	0 (0)	0 (0)	14 (100)
Ofloxacin (OFX)	10 (71.4)	0 (0)	4 (28.6)
Gentamycin (GN)	10 (71.4)	0 (0)	4 (28.6)
Nalidixic acid (NA)	2 (14.3)	4 (28.6)	8(57.1)

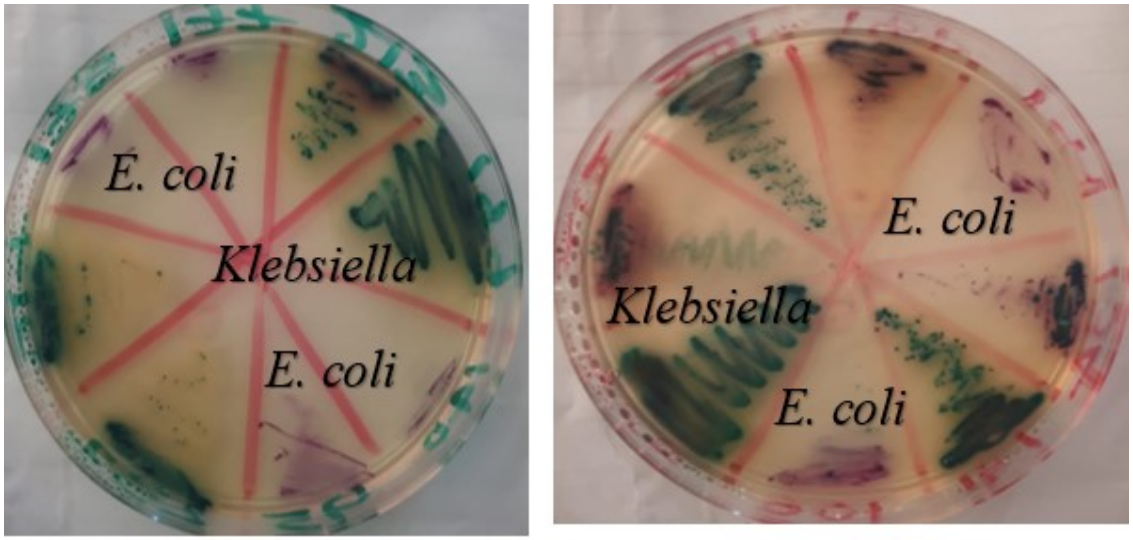

Figure 2: Morphological appearance of *E. coli* and *Klebsiella* on HI chrome ESBL agar.
Pinkish/ purplish = *E. coli*; Bluish/ greenish= *Klebsiella;* Colorless= *Salmonella*

DISCUSSION

The study evaluated the isolation rate of multiple antimicrobial resistant beta-lactamase producing *Escherichia coli* from in cattle, sheep and goat reared within the University of Maiduguri staff residential areas and farms. Our study revealed high isolation rate of lactose fermenting *Enterobacteriaceae* 104 (81.3%) compared with 24 (18.7%) non-lactose fermenting *Enterobacteriaceae.* Of the 104 lactose fermenters, 32 (25%) were identified by biochemical test and ESBL HI chrome agar as *E. coli.* We found *E. coli* to be significantly higher (P= 0.024) among male (34.5%) than female (17.1%). Animals with thin body condition had significantly (P=0.001) higher *E. coli* isolates than those with medium or fat body condition. Also, we observed a higher *E. coli* isolation rate among goats than cattle and sheep. The reason for higher isolation of *E. coli* from male than female animal in this study is unknown since both male and female ruminants exist in the same environment. However, it is expected that female animals harbor more *E. coli* than male because of its physiological and anatomical differences (Drekonja *et al*., 2013; Miller, 2014). The animal with thin body condition had unsurprisingly high *E. coli* isolation rate because thin body condition is mostly associated with disease condition and malnutrition (Matthews *et al*., 2012). *E. coli* is regarded as a common cause of diarrhea in animals, especially ruminants (Coura *et al.,* 2014; Chandran *et al*., 2014). Goats are capricious in nature

and may explain the high *E. coli* isolation rate from goat compared with another ruminant (Guss, 1977). Out of the 32 *E. coli* isolated from 128 ruminants in this study, 20 (15.6%) were identified as Extended spectrum beta-lactamase producing *E. coli*. This finding agrees with Balami *et al.* (2018). It was observed that young ruminants had significantly (P=0.017) higher ESBL producing *E. coli* than adult ruminants. The reason for this finding may be because young ruminants are more susceptible to *E. coli* than adults (Dipeolu, 2010; Raji, 2015). *Escherichia coli* is a common cause of diarrhea and other diseases like colitis, hemolytic uremic syndrome, urinary tract infection, colisepteceamia, enteritis, coligranuloma, arthritis, orchitis, salpingitis, etc. (Foster *et al.,* 2009).

The isolation of ESBL producing *E. coli* in this study is critical with respect to multiple antimicrobial resistance especially the beta-lactam group of antibiotics (Raji, 2015; Ifeyinwa *et al*., 2019). These important antibiotics are the most frequently used antibiotics in human medicine in Nigeria (Akindele *et al.,* 2010; Olayinka *et al.*, 2022). Animals had been marked as the common source of zoonotic transfer of resistant strains of *E. coli* especially in resource poor countries (Daszak *et al*., 2000; Cleaveland *et al*., 2001; Ejeh *et al*., 2017). Hence the control and regulation of the use of beta-lactam antibiotics in animals in Nigeria will help to ameliorate the problems of antimicrobial resistance in Nigeria.

The result of antibiotics susceptibility testing revealed that most of the isolates were resistant to Cefexime, Cefuroxime, Ceftriaxone, Ampiclox, and Imipenem. Beta lactams are mostly used for the treatment of penicillin resistant strains. This finding showed that animals contributed greatly to antimicrobial resistance in the population. Augmentin (Amoxicillin clavulanic acid) is one of the most important drugs uses for the treatment of drug-resistant strain of bacteria in human medicine (Bottenfield *et al*., 1998; Clark *et al.,* 2001). Hence the high rate of resistant strains of *Enterobacteriaceae* in this study is of both medical and veterinary importance (Schmiedel *et al*., 2014). The reason for the high rate of multidrug resistance strains of *Enterobacteriaceae* in this study maybe because of the indiscriminate use of antimicrobials as a growth promoter and preventive purpose in Nigeria (Olaitan *et al.,* 2011; Ejeh *et al* 2017).

The isolation of extended spectrum beta-lactamase producing *E. coli* (ESBL-*E. coli*) from ruminants in the University of Maiduguri campus poses significant public health risks. For example, it could lead to increased antibiotic resistance: ESBL-*E. coli* can inactivate a broad range of beta-lactam antibiotics, the mainstay of treatment for many bacterial infections. This makes infections from these bacteria harder to treat, leading to prolonged illnesses, higher healthcare costs, and even death. The presence of ESBL-*E. coli* in animals creates a reservoir for resistance genes, which can easily transfer to human pathogens through direct contact with animals, contaminated food, or the environment (Ogunleye *et al*., 2013).

Another implication of the isolation of extended spectrum beta lactam producing *E. coli* from ruminants reared in residential areas in the University of Maiduguri is the zoonotic transmission of ESBL-E. Ruminants like cattle and sheep can carry ESBL-*E. coli* in their gastrointestinal tract without showing symptoms. However, humans can become infected through direct contact: farmers, slaughte rhouse workers, and others in close contact with ruminants are at increased risk. Foodborne transmission: improper hygiene during slaughter and meat processing can contaminate beef and milk products with ESBL-*E. coli*, leading to infections when consumed. Environmental contamination: Animal feces can pollute water and soil, potentially exposing humans through water irrigation or contact with contaminated environments. Moreover, farmers use feces from ruminants as manure in vegetable farms in Maiduguri without treatment. Hence, humans can become infected by consuming untreated vegetables from these farms (Ogunleye *et al*., 2013; Ejeh *et al*., 2017).

The spread of ESBL-*E. coli* limits the effectiveness of commonly used antibiotics in human medicine. This leaves fewer treatment options for infections, with potentially less effective or more expensive alternatives. In severe cases, limited treatment options can lead to increased rates of complications and mortality from infections. Community wide impact: The isolation of BL-E. coli poses a threat to the entire University of Maiduguri community, not just individuals with direct exposure to ruminants. The spread of resistance genes can quickly escalate public health challenges, potentially leading to outbreaks of untreatable infections and overburdening healthcare systems. Antibiotic resistance has significant economic implications, including Increased healthcare costs due to prolonged illnesses and ineffective treatments. Loss of productivity due to worker absenteeism and disability. Negative impact on the livestock industry due to potential restrictions on trade and antibiotic use in animal production.

In conclusion, the isolation of extended spectrum β-lactamase producing E. coli from ruminants reared in the residential areas in the University of Maiduguri poses a serious public health concern to people and animal population. This because of the potential zoonotic and reverse zoonotic transmission of resistant strains of E. coli among human and animal population in the University. The University may benefit from policy that prohibits the rearing of farm animals in residential area. There is the need to improve the steward of antimicrobials especially the β-lactam and cephalosporins.

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Conflict of interest

There is no conflict of interest regarding the publication of this paper.

Authors Contribution

FEE and FAL conceived and designed the study. FAL; FEE; RP; and FAA conducted research, provided research materials, and collected and organized data. FAL; FEE analyzed and interpreted data. FAL; FEE; RP and FAA wrote the initial and final draft of the article and provided logistic support. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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